East Fork Lewis River Watershed:
Water Quality and Flow in Manley Creek

Clark County Public Works
Water Resources Section

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Introduction

This report summarizes water quality data collected in 2005 from Manley Creek where it flows through Lower Daybreak Park. Manley Creek is a relatively small tributary of the East Fork Lewis River near Battle Ground in Clark County, Washington. Lower Daybreak Park is approximately 112 acres in county ownership northwest of Battle Ground at NE 259th Street. Data was collected by an Americorps team focused on projects in the East Fork Lewis River (EFLR) basin.

Watershed & Site Condition

The Manley Creek watershed drains about two square miles before flowing into the EFLR. Beginning about two miles from the Battle Ground city limits, the creek's headwaters flow to the northeast through a mostly rural landscape. Manley Creek flows over a terrace to the EFLR floodplain before turning northwest towards the river. Overall, the watershed is developed primarily for rural residential and agricultural uses. Much of the forest cover has been cleared. The dominant soil type is Puyallup fine sandy loam which is a well-drained soil type. This soil type is primarily made up of sand deposited by the EFLR during previous large floods. The creek at Lower Daybreak Park (hereafter referred to as the Park) meanders through farm fields with non-native grasses and shrubs as the dominant vegetation. On the southwest side of the park is a remnant piece of forest on a steep slope with perennial springs. The remainder of the site has been logged several times and used in the past as a dairy farm. It is a mostly flat area (<3% slope) that is part of the EFLR floodplain. Manley Creek enters the Park at the SE corner and empties into a backwater slough of the EFLR at the northwest end, which is also where Mill Creek enters the river.

Monitoring Activity Summary

Manley Creek was monitored by the Americorps team monthly from April through December, 2005. Water quality data was collected at four separate sites for temperature, dissolved oxygen, pH, conductivity and turbidity (Table 1). The sampling sites were all within the boundaries of the Park and the locations are shown on the map (Figure 1). In addition, the Americorps team measured flow at MAN015 and MAN020 monthly, and placed three water temperature data loggers in the creek to record continuous temperature data throughout the summer at sites MAN010, MAN015, and MAN020.

Table 1. Water quality monitoring station information.

Clark County Station Code	Station Location Description
MAN010	Most downstream point of Manley Creek at the foot bridge below the pond
MAN015	Upstream of the pond, downstream of the culvert passing under the driveway to the large, vacant house
MAN018	Just upstream of the fish bypass structure
MAN020	Downstream of the large culvert (middle of field)

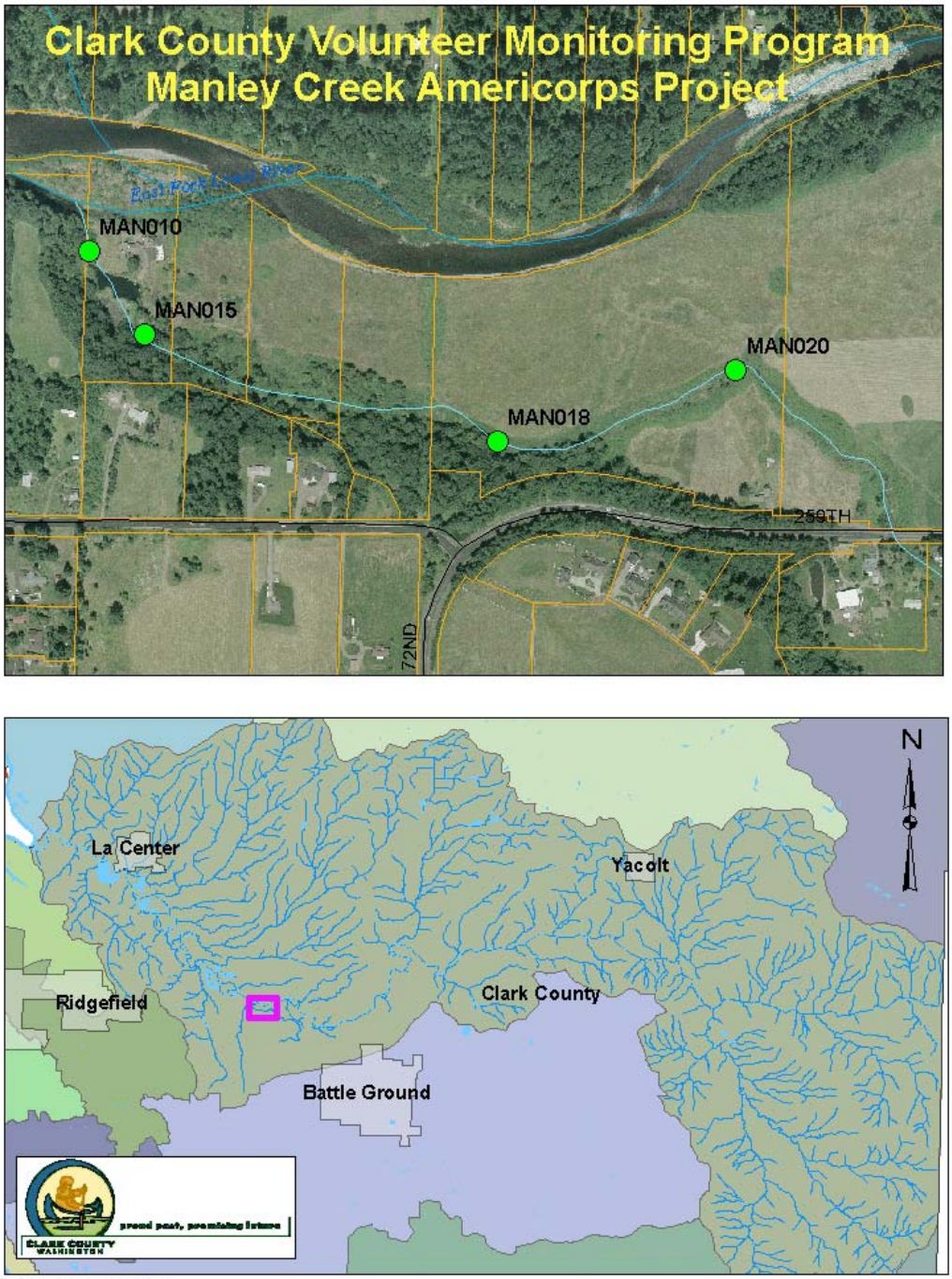

Figure 1: Top map shows the Lower Daybreak Site with the four sampling locations indicated by green dots; lower map is of the EFLR watershed with the top map extent highlighted in pink.

Results of Flow Measurements

Flow measurements were taken at MAN015 and MAN020 monthly. Curiously, MAN020 is upstream of MAN015 and yet it had a higher flow in almost all months (Figure 2). In addition, MAN015 was completely dry in September and October even though MAN020 had measurable flow in all months. Although the margin of error for the flow measurements is ± 1cfs, data consistently shows that the creek loses flow as it traverses the Park. As Manley Creek crosses the Park the infiltration rate apparently exceeds the flow as a result of the soil type, underlying geology and low summer flows. The large in-line pond built in 1978 near the mouth of Manley Creek may contribute to infiltration by slowing down the creek. MAN010, downstream of the pond, was dry from mid-August through October based on visual surveys and continuous temperature data.

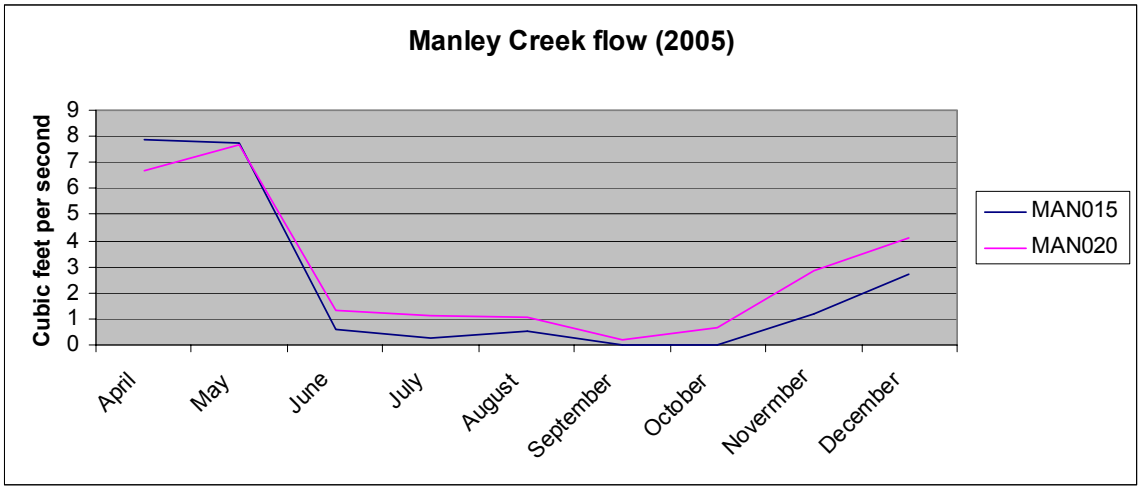

Figure 2: Stream discharge curves for two sites on Manley Creek from April to December, 2005.

Water Quality Results

Clark County staff use a water quality index that was developed by the Oregon Department of Environmental Quality for communicating and tracking volunteer collected data (http://www.deq.state.or.us/lab/wqm/wqimain.htm). The Oregon Water Quality Index (OWQI) analyzes a defined set of eight water quality parameters and produces a score describing general water quality. OWQI scores range from 10 (worst case) to 100 (ideal water quality).

A water quality index is a single number which expresses water quality by integrating multiple measurements of water quality parameters. This index provides a simple, concise, and valid method for expressing the significance of regularly collected data. As with most methods for generalizing water quality data, there are limitations to the interpretation of the data. An index provides only a summary of the data. It is important to note that the Manley Creek OWQI scores are based only on three of eight possible parameters: dissolved oxygen, temperature, and pH.

Figure 3 below shows the water quality index scores for two different categories: summer (June-September) and fall, winter, spring (FWS) for each site.

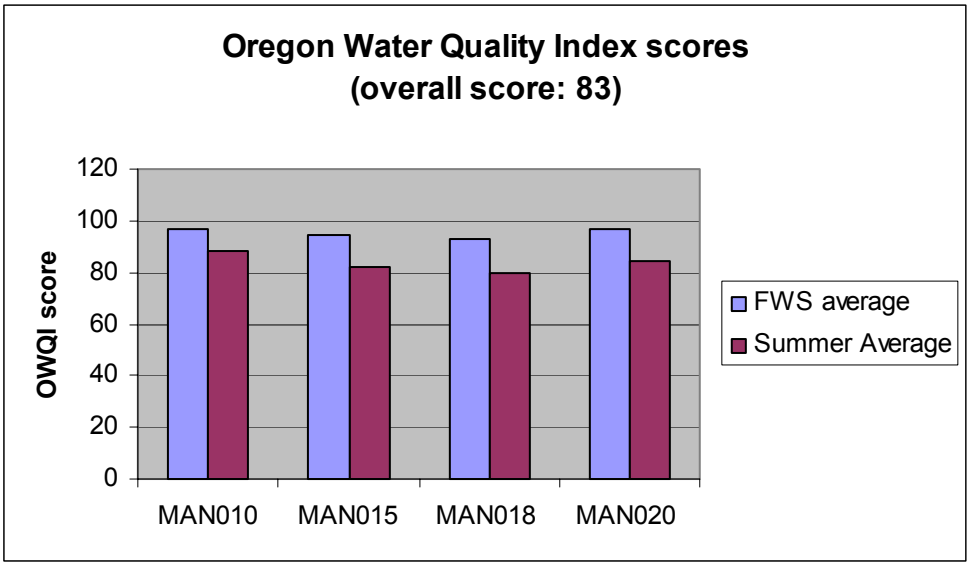

Figure 3: OWQI scores for Manley Creek in 2005 based on three parameters.

Overall, Manley Creek earned an index score of 83 which is in the 'fair' category. The OWQI overall score is calculated using the average of the summer scores, which is typically the most limiting time for aquatic life. High temperatures and low dissolved oxygen readings brought the summer scores into the fair category for all sites. MAN010 was dry from August through October and so the summer index score is based on fewer readings compared to the other sites.

Dissolved Oxygen

Dissolved oxygen is necessary for all aquatic life and is one of the most important parameters in determining water quality. Oxygen levels are influenced by temperature, air pressure, photosynthesis and bacterial decomposition in the stream. Typically, dissolved oxygen levels decrease in the summer months when stream temperatures are higher and algal production increases. Dissolved oxygen usually ranges between 6-13 milligrams per liter (mg/L) with levels below 7 mg/L likely to cause stress for cold-water fish species. Manley Creek followed the typical pattern for Pacific Northwest streams with dissolved oxygen levels dropping during the summer months to below optimal for salmonids and pollution-sensitive macroinvertebrates. The MAN015, MAN018, and MAN020 stations had averages of 8.6 mg/L, 8.2 mg/L and 8.9 mg/L, respectively. Importantly, all sites had readings below 6mg/L in July and August, indicating a very stressful environment for most aquatic life. In some cases measurements were so low as to indicate a problem with the dissolved oxygen meter and not an accurate reading. These measurements were eliminated from the data set.

pH
pH is a measure of the acidity of water as ranked on a logarithmic scale of 1 to 14. As the pH drops, acidity of the water increases. The largest variety of organisms flourishes between a range of 6.5-8. A pH of 5 or lower is harmful to juvenile forms of most species including salmonids. Manley Creek appears to have a stable pH with all readings falling between 6.5 and 8.5 pH units. The average pH among the sites was quite uniform, ranging from 7.2 to 7.5. There was a slight decrease in average pH values between MAN020, MAN018, and MAN015.

Conductivity
Conductivity is a measurement of the ability of water to carry an electrical current and depends on the presence of ions. It does not measure any specific compounds in the water. This parameter is not part of the OWQI but was part of the data collection at Manley Creek. Sources of ions include dissolved salts, minerals, heavy metals and acids present in the water column. No standards have been set forth for proper conductivity values because there is a great amount of variation. Typical values for a stream can range between 50-500 µmhos/cm. Extreme changes in conductivity can indicate the addition of a substance into the stream that is not typically there. The 2005 data establishes the characteristic conductivity values for Manley Creek, averaging just over 100 µmhos/cm and ranging from 80 to 150 µmhos/cm. Although only slightly higher on average there were times of the year when conductivity at MAN020 was nearly 30 µmhos/cm higher than at MAN015. The average conductivity reading from a nearby monitoring station on the EFLR for water year 2003-2004 was 41 µmhos/cm. Manley Creek contributes water with a higher amount of dissolved ions than the EFLR which may reflect the underlying geology of the watershed or a contribution of ions from other sources.

Turbidity
Turbidity is a measurement of water clarity. This parameter is not part of the OWQI but was part of the data collection at Manley Creek. High turbidity indicates a high amount of suspended particles in the water which can harm salmonids and other aquatic life. The state water quality standards allow for only slight increases (≤5 NTU) in turbidly over background conditions, which are often considered to be near zero in small streams like Manley Creek. Almost all the turbidity readings in Manley Creek were below 5 NTU with the highest reading being 7.5 NTU. This indicates a very low sediment load and it appears that turbidity is not a year-round problem in the creek. Please note, however, that sampling was done randomly and not in conjunction with storm events so it is not known if turbidity levels are an issue during storms.

Stream Temperature
An assessment of water temperature is possible using the continuous datasets from 2005. Americorps team members installed three water temperature data loggers that recorded hourly temperature readings from May to October. Washington State stream temperature criteria set a maximum temperature of 64^{o}F to protect sensitive aquatic life like salmon and trout. Water temperature under the current state criterion is measured by the 7-day average of the daily maximum temperature (7-DADMax). The 7-DADMax is the average of daily maximums based on a moving seven-day window. So, for any given

seven days there is one averaged maximum temperature. Scientists can use this to determine how often water temperature exceeded the standard, and get an average for the month or season. The 7-DADMax water temperature for the summer season was 71.4ºF for MAN010, 70.5ºF for MAN015, and 70.7ºF for MAN020 (Figure 4).

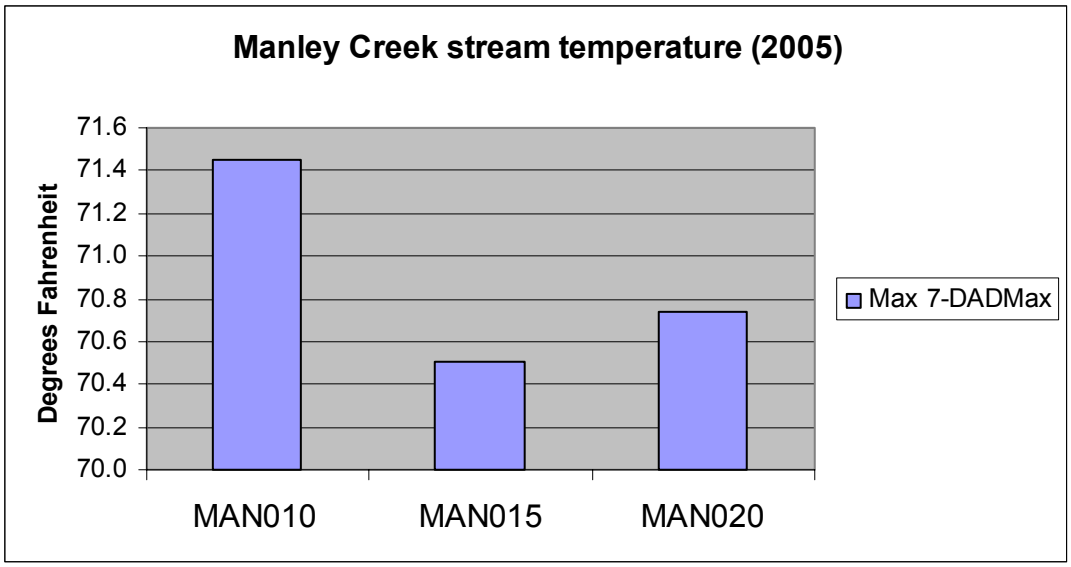

Figure 4: The 7-DADMax water temperature from May to October, 2005.

Temperatures over 70ºF bring stream temperatures into the critical category for spawning, rearing and passage of salmonids. Looking at the number of days that stream temperatures were in the critical period for salmonids is also important. In 2005, water temperature in the stream exceeded the state standard (64^{o}F) for over 50 days at all sites and exceeded 70ºF for over 10 days at all sites (Figure 5). More exceedences were logged at the sites further downstream indicating a warming trend as the creek crosses the Park. This is due to the extremely low flows in the summer months, lack of riparian vegetation and ponding behind beaver dams.

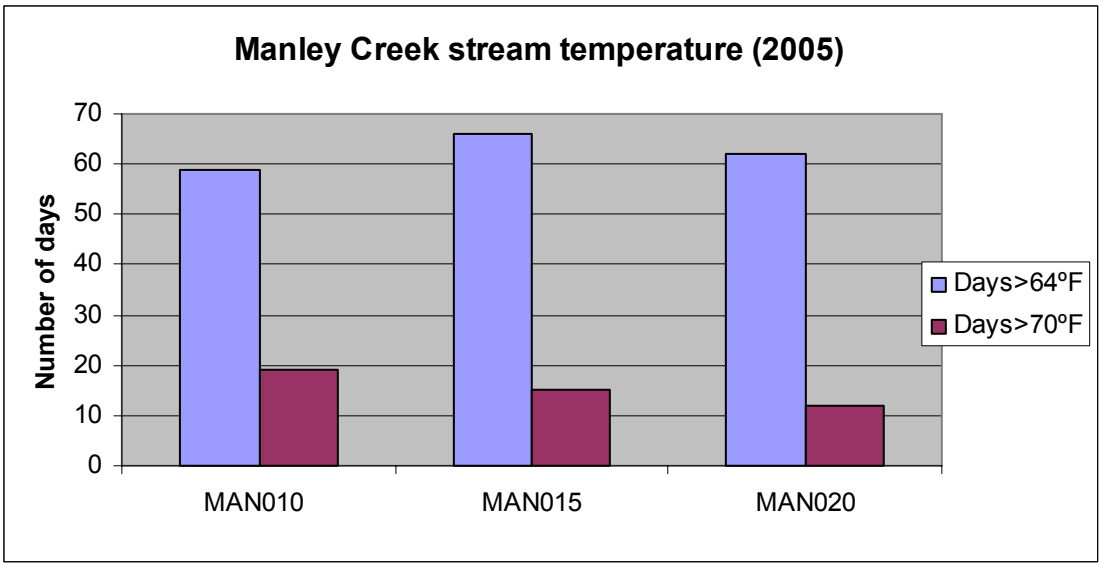

Figure 5: Stream temperature in Manley Creek with total number of days over 64ºF and total number of days over 70ºF at each site.

Conclusion and Future Management

Analyzing stream health in relation to the needs of salmonids is common in our region. Salmon redds have been found in Manley Creek and future management plans will most likely take the needs of salmonids into consideration. From a water quality standpoint Manley Creek is a stressful environment for cold-water fish and pollution-sensitive macroinvertebrates to live and to rear offspring during the summer months. High temperatures, low dissolved oxygen levels, and low flows are the main source of the stress. Another cause for concern was the lack of water in the lower reach of Manley Creek from mid-August through October. Obviously, any fish that want to move into Manley Creek from the EFLR to spawn have to wait for the creek to begin flowing again in the late fall. The lack of water could also be seriously impacting the health of the aquatic macroinvertebrate community.

Depending on management objectives, the culvert at MAN020 will need either removal or maintenance to ensure fish passage and to avoid flooding during high water. The culvert consists of a 30” concrete pipe and a 24” pipe. The larger pipe is 95% blocked by vegetation and sediment. The majority of flow goes through the smaller pipe which is about 40% blocked. If the road crossing is no longer needed, replacement of the culverts with a foot bridge is the best option for stream health and fish passage.

Beaver are part of the natural stream processes but regulation of their activity may be necessary depending on management goals. Beavers are active on the property with two large dams and associated ponding between MAN015 and MAN020. MAN018 is just upstream of a beaver dam although there is enough flow to take water quality readings because of the fish bypass structure just downstream. A new beaver dam was noted in December just upstream of MAN015 and another fish bypass structure may be needed at that point.

Future monitoring will determine if the conditions named above were particular to 2005 or if they are on-going issues. An additional water quality monitoring station just below the NE 259th Street crossing would be beneficial to determine water quality status as the creek enters the county property. The amount of warming that occurs as the stream crosses the county property can be determined next year through the installation of a water temperature probe at this point. Assessing the creek's health based on the macroinvertebrate population is also recommended. The Americorps team was not able to collect a macroinvertebrate sample in 2005 because of low flow. We will encourage next year's team to sample macroinvertebrates in early summer or late fall when flows are higher.

Clark County Water Resources is committed to providing training and equipment for continued monitoring of Manley Creek. We would like to thank the hard work of the Americorps team members who collected the data, and to thank Rich Kolb, Brian Potter, and Vancouver-Clark Parks for the collaboration.